Fermilab
Linac Department

Application Programs for the Monitoring and the Commissioning of the 400 MeV Fermilab Linac

Elliott McCrory

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The applications programs for the Linac Upgrade are divided into three categories: (1) Monitoring the old equipment, (2) monitoring the new equipment (e.g., the klystrons), and (3) commissioning beam in the new Linac. This memo discusses these applications and the overview of how these programs are going to help the commissioning and the reliability of the 400 MeV Fermilab Linac.

A list of the specifications for the Linac Upgrade applications can be found in the Linac File (see Lisa Lopez).

1. Monitoring the Old Equipment

It is important to mention the monitoring of the old equipment because of the similarity of this operation with those required for the new linac. We have been controlling the old 201 MHz linac successfully for eleven years (since 1982) through the Linac Control System, both locally and by using application programs in the main control room (MCR). Recently (Feb., 1992), we replaced the old Linac local control system with a new one (see internal note LU-205 for information on the Linac Control System). The changeover has produced no problems, in particular, no problems with the existing applications in the MCR. The most widely used programs are the general-purpose parameter page, the linac steering program and the binary status-and-control page for the RF systems.

Some modifications have been made to linac-specific applications because of the controls changeover last year. The parameter page no longer needs to treat Linac devices specially; the readings for these devices which are reported to the console at 1 Hz are now averaged locally over the previous 15 readings, with priority given to those readings which occurred during the cycles which contained beam. The linac steering program has required a re-work of the hardware for the automatic 15Hz beam request. The binary status/control page (L25) has been re-written.

Another significant aspect of monitoring the old equipment is the alarms reporting. Every linac analog and binary reading (including the values derived from these readings, e.g., sum of a series of channels) can be inserted into the alarm scan, and this device is reported to the central AEOLUS

alarms task when it goes out of tolerance. (Beam can optionally be inhibited by this alarm, too.) This is the primary means by which the linac is monitored. The alarm scan happens at 15 Hz in the local control station.

2. Monitoring the New Equipment

The monitoring of the new (klystron) equipment is underway from the MCR. The alarms and limits are in place, and the Operators are sensitive to these alarms. Engineers monitor their equipment from the Macintosh consoles in the Linac Gallery and from their offices. For those times that they need to see their devices in the MCR, there are parameter pages set up for the new equipment and, additionally, a set of X-Windows applications are available for graphical display of the main systems (klystron, low-level RF, modulator and water systems; see "Easy and Effective Applications Programs using DataViews," E. McCrory, Proceedings of the 1993 IEEE PAC, Washington, DC, for more information on this program). A binary status and control page has also been written for the new equipment (L26: J. Utterback, "The Klystron Binary Status Page," internal note, LU-198).

3. Commissioning the New Linac

The most challenging aspect of the application programs for the Upgraded Linac is those programs which deal with the commissioning of the new accelerator. We have analyzed the types of measurements which will be necessary and have written the applications, where appropriate. In our experience with the old Linac, most of the measurements needed for the smooth operation of the Linac are done from the parameter page. We fully expect this to be true for the new linac. Nevertheless, we have generated several new applications to semi-automatically handle the anticipated routine measurements. Additionally, there are new types of measurements which we feel will be necessary.

We have, in the past, benefitted from an automatic emittance measurement application. Since it will be possible to measure the emittance in several places in the new Linac, a general-purpose wire-scanner control program has been written (E. McCrory, "Scanning Wires in the Upgraded Linac," internal note, #LU-____). Also, a companion emittance calculation program has also been written (F. Harfoush, "Emittance Calculations," internal note, #LU-184 and LU-199).

Beam steering is more important in the new Linac than it has been in the old Linac: The beam is expected to be slightly larger because the quads are farther apart, and the aperture is 3 cm (reduced from 4 cm). A new steering program is available (K. Junck, "Steering Considerations for the 400 MeV Fermilab Linac," internal note, #LU-197 and #LU-____). This application uses the beam position monitors to minimize the deviation from the best trajectory throughout the entire linac.

The tuning of the phase and gradient of the new side-coupled tanks will be accomplished through a program referred to as the phase-scan match technique (T. Owens, "The Phase-Scan Matching Technique for Linac Tuning," internal note #LU-186 and #LU-202). This topic has been thoroughly researched, and we are confidant that this measurement technique will tune the new 805

MHz modules much more accurately than the present 201 MHz tanks are tuned. Studies on the more-detailed Δt procedure are underway.

We are also attempting to incorporate an accurate model of the new Linac in an application program available in the MCR. This program is based on the well-known PARMILA program from Los Alamos. (See T. Kroc, "PARMILA Modeling of the Upgraded Linac," internal note #LU-____). To check the validity of the PARMILA code, we have independently developed the LANA code to run on the Sun Workstations in the Linac Department (K. Junck, "Using LANA for Analysis of the 400 MeV Fermilab Linac," internal note, #LU-197).

It is anticipated that we have not anticipated all of the necessary measurements and application programs for commissioning the new Linac. To that end, several scientists/programmers are ready to write these unforeseen applications quickly. The programmers I can call upon in this situation are: me, Mike Halling (AD/PBar), Kevin Junck (AD/Linac), Tom Kroc (AD/Linac), Bill Marsh (AD/Controls) and Brian Hendricks (AD/Controls).